Center Independent Research & Development: GSFC IRAD

Digital Array Gas filter Radiometer Passive Methane Sensing Instrument (DAGR)

Completed Technology Project (2017 - 2019)

Project Introduction

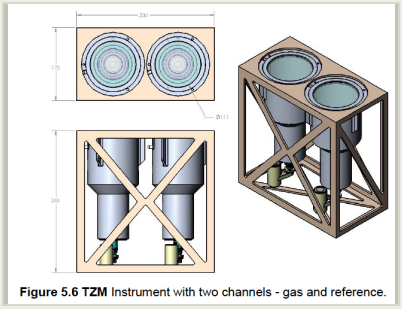
As one of the driving greenhouse gases, methane's (CH_4) presence in the atmosphere affects the Earth's temperature and climate system. It is emitted from a variety of anthropogenic (human-influenced) and natural sources, among them biomass burning, fossil fuel combustion, and biogenic sources (including wetlands and rice paddies). Methane is hard to track because it comes from many sources and is chemically oxidized in the troposphere by the hydroxyl radical. It also becomes well-mixed in the atmosphere by meteorological systems and diffusive process as it is transported across continents and oceans. Complicating matters even further is the 9-year methane atmospheric lifetime that allows it to accumulate in the atmosphere. Increasing methane not only affects tropospheric ozone pollution levels, but methane also absorbs in the infrared, making it 86 times more potent at trapping heat as CO_2 over a 20-year period.

Recent studies (Saunois et al., 2016) suggest that concentrations of methane in the atmosphere are now rising at their fastest pace in two decades, thus raising the urgency of developing and flying space-based methane measuring instruments.

The development of the proposed compact, **D**igital **A**rray **G**as filter **R**adiometer instrument (**DAGR**) will serve as the first step in establishing NASA as the leader in constellation-based, temporally nimble, space-based methane measurements. DAGR possesses a footprint and power requirement that readily enables its flight with the already in development NASA active LHR methane/methane isotope instrument on the same smallsat bus. DAGR is the first to exploit a new method of sensing greenhouse gas using passive sensor images of solar backscatter radiation. The approach is call the **T**errain and **Z**enith angle **M**odulation (**TZM**) method where the natural modulation of gas column is detected and quantified using an imaging **G**as **F**ilter **C**orrelation **R**adiometer (**GFCR**). This novel method, mitigating the ambient column difficulties of sensing surface gas concentrations, will be definitively validated by the proposed effort. If successful, it opens the door to a new (GATS Inc. patent pending) passive sensing technique that could revolutionize global methane observing systems.

Anticipated Benefits

The DAGR effort will have two main benefits 1) a demonstration of the ability to produce a ratio image with the required image matching and S/N to perform the methaneTZM measurements and 2) a demonstration of the Terrain and Zenith Modulation (TZM) analysis method which uses the ratio image to detect and quantify the methane column modulation caused by variations in the scattering surface distance (ex terrain height) from the sensor. This will create an image analysis software that can efficiently extract the methane concentrations from the TZM signal in the ratio images, as well



TZM Instrument with two channels - gas and reference.

Table of Contents

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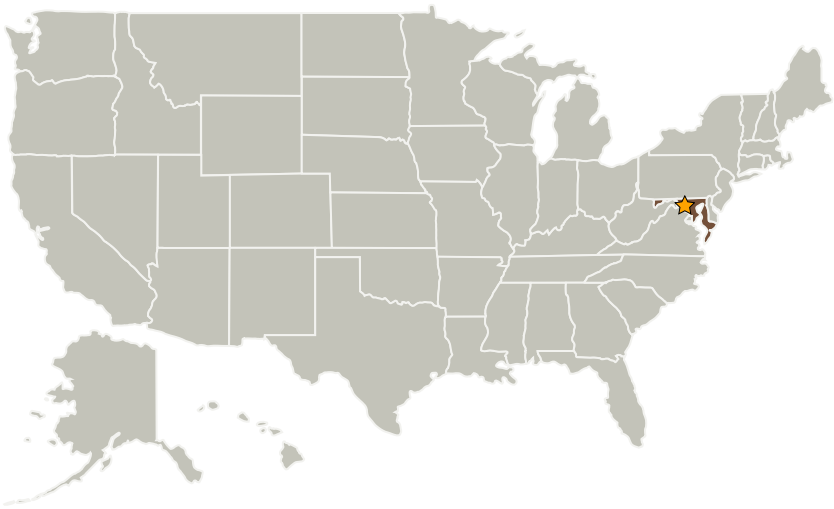
as identify any perturbations in the scene due to methane plumes.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Managers:

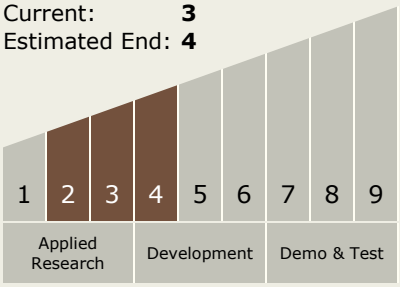
Matthew J Mcgill
William E Cutlip

Principal Investigator:

Paul Newman

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **4**



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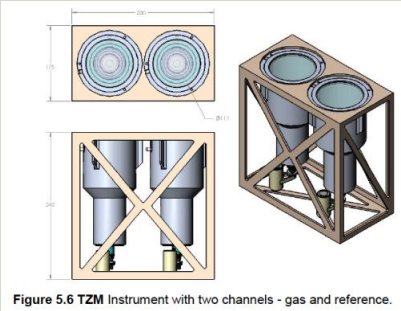
Images



TZM_instrument
TZM Instrument with two channels - gas and reference.
(https://techport.nasa.gov/image/34345)

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.3 Optical Components

Target Destination

Earth

Supported Mission Type

Projected Mission (Pull)